

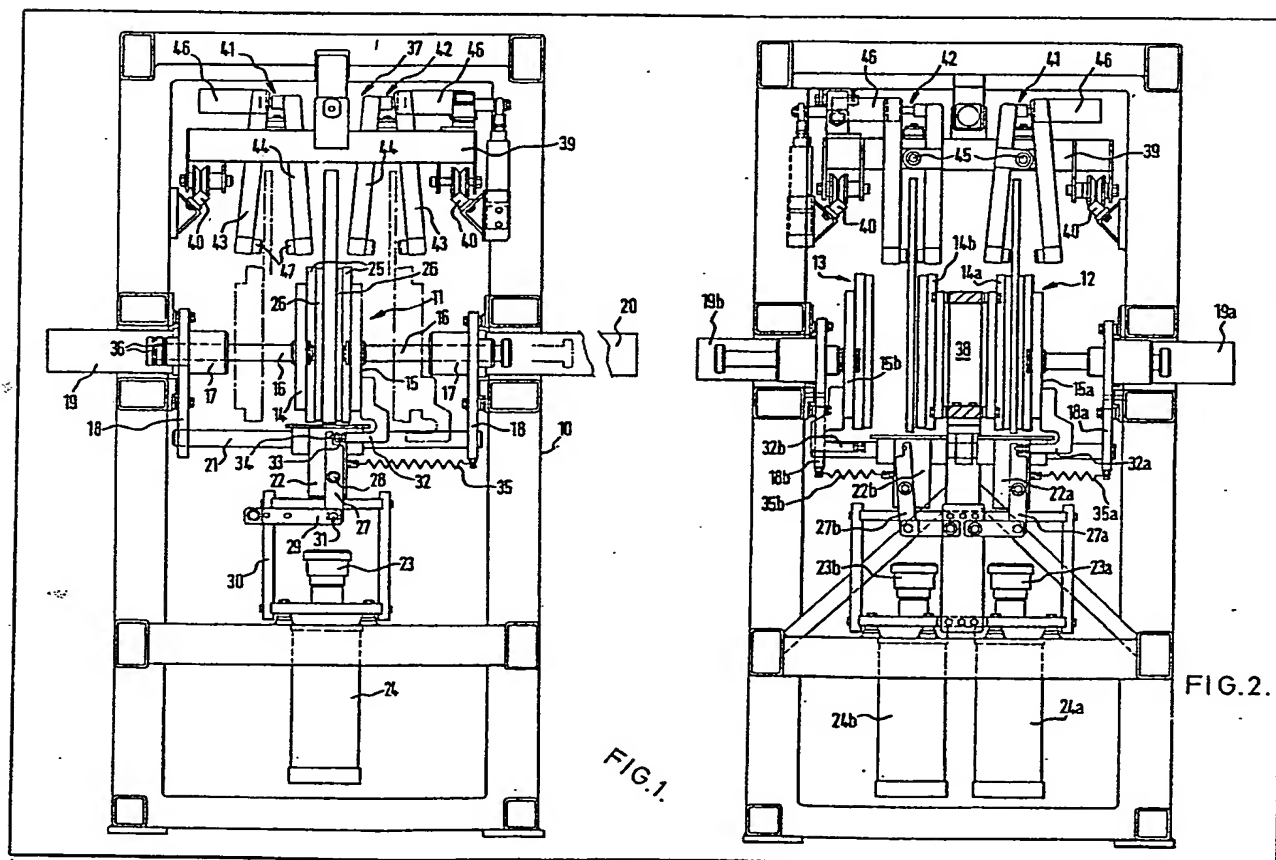
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## (54) Apparatus for and a method of cleaving laminated plate

(57) The apparatus comprises first, second and third splitting units (11, 12 and 13) contained in a common housing. Each splitting unit comprises two gripper members (14, 15) relatively movable towards and away from each other by power operated means (19 and 20) such that with a plate of laminated material disposed between the gripper members, the latter can be moved towards each other to grip opposing faces of the plate and then can be moved away

from each other to apply a splitting strain. A trigger cut at an edge of a desired cleavage plane is formed in the plane by a blade mounted in a carriage (22) and operated by power operated means (24). A self centering device positions the blade midway between the gripper members prior to the blade forming the trigger cut. A transfer mechanism comprises a carrier (39) and two holding devices (41 and 42) for taking hold of the two parts of laminated plate split in the first splitting unit and transferring the two parts to the second and third splitting units respectively.



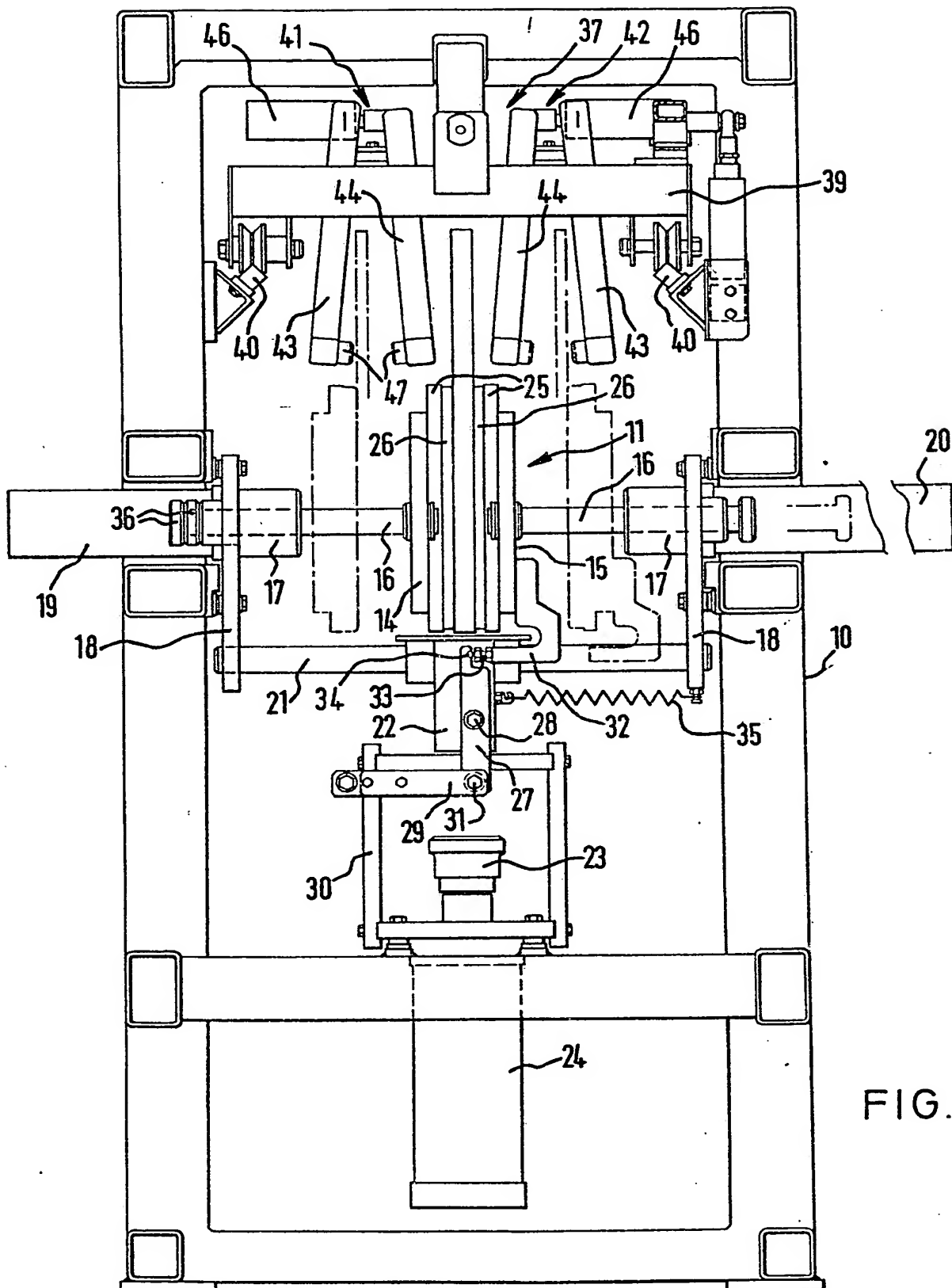


FIG.1.

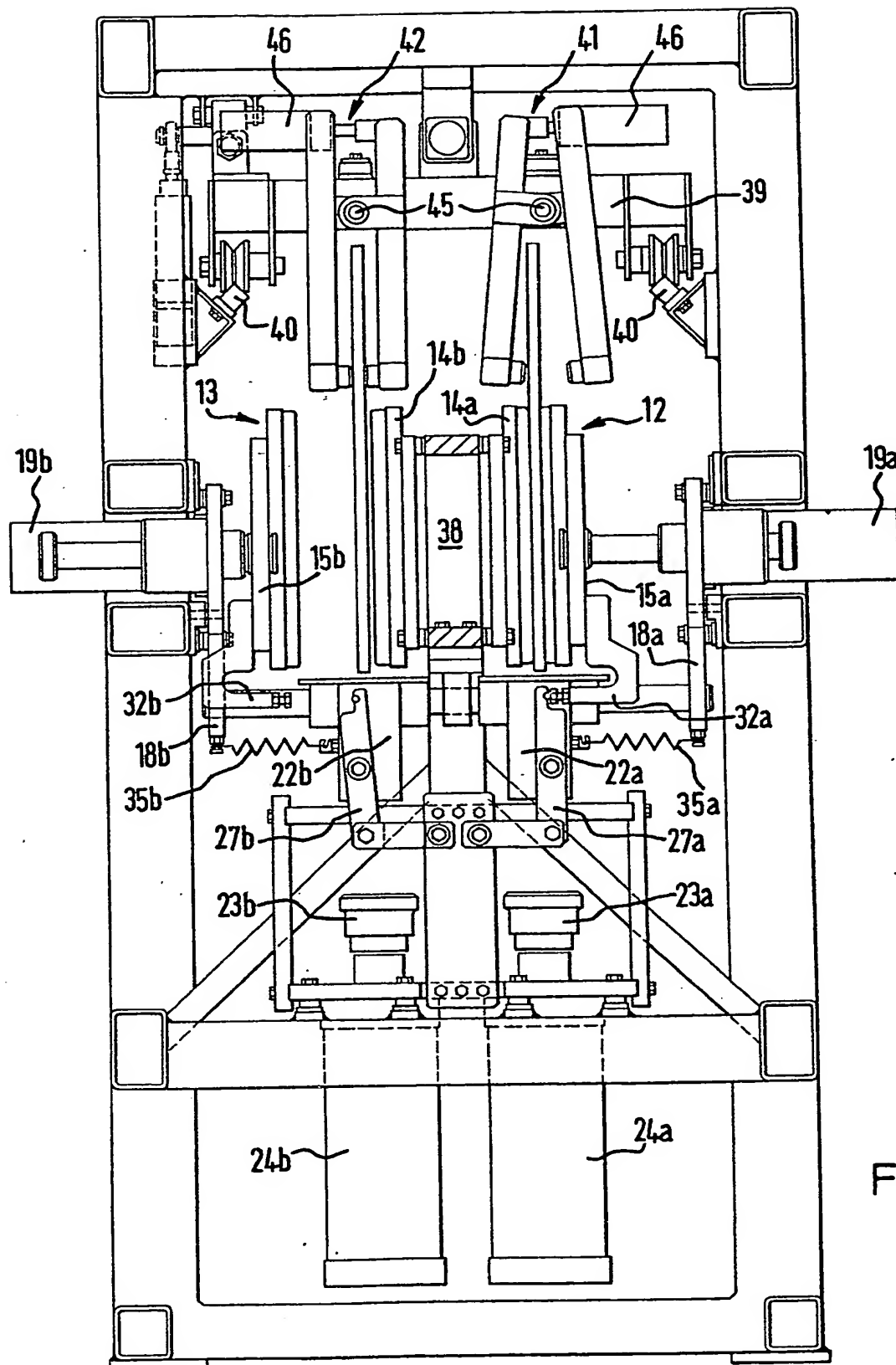


FIG. 2.

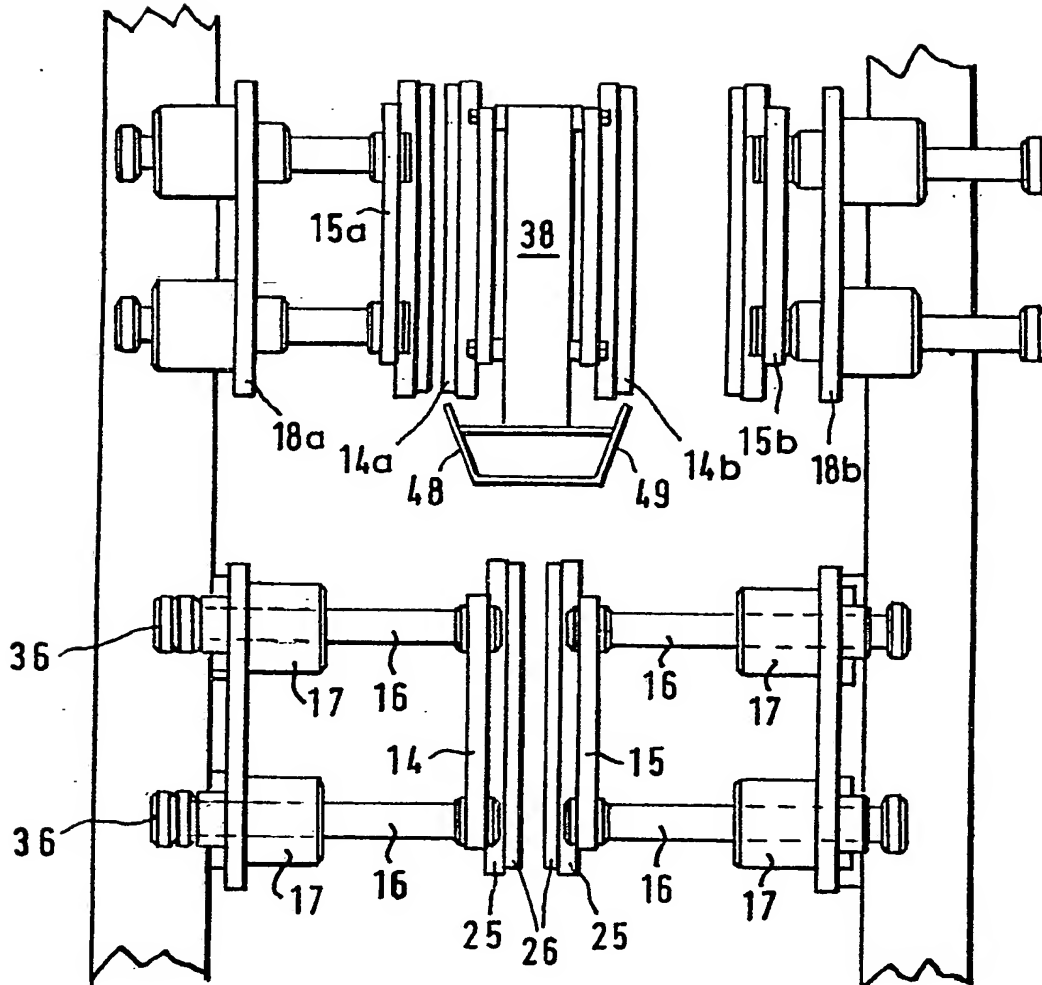


FIG. 3.

## SPECIFICATION

**Apparatus for and a method of cleaving laminated material**

The invention relates to apparatus for and a  
5 method of cleaving laminated material, e.g. slate.

In our published British Patent Applications  
Serial Nos. 2067954A, 2067955A, and  
2068291A we describe apparatus for cleaving  
laminated material, but this apparatus is able only  
10 to effect a single cleaving operation between  
successive interventions by an operator and whilst  
this apparatus has proved quite satisfactory in use  
it is not particularly efficient.

According to one aspect of the present  
15 invention, there is provided apparatus for cleaving  
laminated material, provided with first, second and  
third splitting units contained in a common  
housing, each splitting unit comprising two  
gripper members, first power operated means for  
20 relatively moving the gripper members towards  
and away from each other such that, in use, with a  
plate of laminated material disposed between the  
gripper members, the latter can be moved  
relatively towards each other to grip opposing  
25 faces of the plate and then can be moved  
relatively away from each other to apply a splitting  
strain to the plate, a blade, and second power  
operated means for causing the blade to apply an  
impact to the plate in a direction perpendicular to  
30 the direction of relative movement of the gripper  
members to form a trigger cut at an edge of a  
desired cleavage plane, and a transfer mechanism  
for taking hold of the two parts of a laminated  
plate split in the first splitting unit and transferring  
35 said two parts to the second and third splitting  
units respectively.

Preferred and/or optical features of the  
apparatus are set forth in claims 2—17.

According to another aspect of the present  
40 invention, there is provided a method of cleaving  
laminated material using the apparatus according  
to said one aspect of the invention and comprising  
the steps of (a) disposing a plate of laminated  
material between the two gripper members of the  
45 first splitting unit, then (b) relatively moving the  
gripper members towards each other to grip the  
plate of laminated material, then (c) relatively  
moving the gripper members away from each  
other to apply a splitting strain to the plate of  
50 laminated material, then (d) forming a trigger cut  
at an edge of a desired cleavage plane of the plate  
of laminated material, then (e) transferring the  
plate parts to the second and third splitting units  
respectively, and then (f) repeating steps a—d in  
55 each of the second and third splitting units.

The invention also resides in laminated material  
particularly slate split by the above method.

The invention will now be more particularly  
described by way of example with reference to the  
60 accompanying drawings, wherein:

Figure 1 is a view of one end of one  
embodiment of apparatus according to the  
invention, with parts removed for reasons of  
clarity,

65 Figure 2 is a view of the other end of the  
apparatus of Figure 1, again with parts removed  
for reasons of clarity, and

Figure 3 is a plan view of the apparatus shown  
in Figures 1 and 2 taken from above the gripper  
70 members but below the holding devices.

Referring now to the drawings, the apparatus  
shown therein comprises a frame-like support  
structure 10 mounting at one end a first splitting  
unit 11 and at the other end a pair of splitting  
75 units 12 and 13.

The splitting unit 11 is shown in Figure 1 and  
comprises first and second gripper members 14  
and 15. Each gripper member 14, 15 is fixed to  
the free ends of two horizontally spaced parallel  
80 rods 16 guided for axial sliding movement in  
bosses 17 fixed to a mounting plate 18 which is in  
turn secured to the support structure 10. The  
gripper members 14 and 15 are movable towards  
and away from each other by respective  
85 pneumatic piston and cylinder units 19 and 20.

The mounting plates 18 also carry two  
horizontally spaced parallel guide bars 21  
disposed below the gripper members 14 and 15.  
A blade carriage is mounted on the guide bars 21  
90 and is movable therealong in a direction parallel to  
the direction of movement of the gripper  
members. The blade carriage 22 supports a blade  
(not shown) which is guided for vertical  
movement, i.e. movement in a direction  
95 perpendicular to the direction of movement of the  
gripper members 14 and 15 and of the blade  
carriage 22, in response to an impact applied  
thereto by a hammer head 23 mounted on the free  
end of the piston rod of a pneumatic impact piston  
and cylinder unit 24. Such impact piston and  
100 cylinder units are well known and possess the  
advantage that very rapid acceleration of the  
piston rod is produced by a differential area  
arrangement which suddenly exposes the full area  
of the piston to high pressure air built up in a  
105 reservoir in the lower end of the cylinder.

Each gripper member is in the form of a suction  
device which comprises a rigid plate 25 having at  
least one and preferably two annular sealing  
members 26 formed of resilient material which is  
110 sufficiently compressible to seal against an  
irregular surface of a laminated plate. It has been  
found to be particularly advantageous to provide  
sealing members 26 of cellular and preferably  
mono-cellular material such as neoprene foam.  
Near to the centre of the plate 25, there is a port  
(not shown) which is connected to a source of  
negative pressure such as a vacuum pump, and  
115 inwardly of the sealing members 26 there are  
provided several abutments (not shown) formed of  
resilient material, such as neoprene foam, which  
are so arranged as to prevent excess bending of a  
laminated plate when negative pressure is applied  
thereto, as any such excess bending may result in  
120 pillaring of the laminated plate. The suction  
devices are more clearly shown in our published  
British Patent Application Serial No. 2068291A  
(Application No. 81 01059).

A horizontal base plate (not shown) is mounted

above the guide bars 21 and just below the gripper members 14 and 15 to support a plate of laminated material to be split. The base plate has a slot therein to allow the blade to strike the lower edge of the laminated plate as will be more particularly described hereinafter.

The blade carriage 22 is provided with a self-centering device to automatically locate the blade for movement in a plane midway between the gripper members 14 and 15. The self-centering device comprises a lever arm 27 connected intermediate its ends to the carriage 22 for pivotable movement about an axis 28 normal to the direction of relative movement of the gripper members and normal to the direction of movement of the blade during an impact stroke. The lower end of the lever arm 27 is pivotably connected to one end of a generally horizontally extending arm 29 which is connected adjacent its other end for limited pivotable movement to a support unit 30 fixed to the support structure 10. The limited pivotable movement of the arm 29 allows the pivot axis 31 between the lever arm 27 and arm 29 to shift slightly. This is necessary because the vertical distance between the axis 28 and the axis 31 will vary as the lever arm 27 pivots about its axis 28. An abutment 32 is fixed to the gripper member 15 and has an adjustable contact member 33 engageable with a ball (or horizontally extending roller) 34 held captive in the upper end of the lever arm 27. The ball (or roller) 34 provides point (or line) contact with the contact member 33 and the distance between the point (or line) contact and the axis 31 is twice that between the contact point (or line) and the axis 28. In addition, a coiled tension spring 35 is connected between the carriage 22 and the mounting plate 20 to urge the carriage to the right (as shown in Fig. 1) i.e. towards the abutment 32.

The gripper member 14 is arranged so as to reach a set position in which collars 36 on the rods 16 register on respective bosses 17 before the gripper member 15 closes in on a plate of laminated material disposed between the gripper members 14 and 15. Moreover, the contact member 33 is set so that when it first engages the ball 34 on movement of the gripper member 15 towards the gripper member 14 and with the gripper member 14 in its set position, the blade is located for movement in a plane midway between the two gripper members. Further movement of the gripper member 15 towards the gripper member 14 will result in pivotable movement of the lever arm 27 and because of the respective spacings between the contact point and the axes 28 and 31, the carriage will move in the same direction as the gripper member 15 but by half the distance moved by the gripper member 15. Consequently, the plane of vertical movement of the blade will always be located midway between the two gripper members immediately prior to an impact stroke.

In operation, the plate of laminated material to be split is located between the gripper members 14 and 15 and supported in a generally vertical

position on the horizontal base-plate. The gripper members 14 and 15 are moved towards each other by their respective pneumatic piston and cylinder units 19 and 20 but, as aforesaid, the gripper member 14 is arranged to reach its set position before the gripper member 15 closes in on the laminated plate. The two gripper members engage opposing faces of the laminated plate with the sealing members 26 sufficiently compressed to seal against the plate which may have an irregular surface. Pneumatic pressure is then applied to the opposite ends of the piston and cylinder units so that a splitting strain is applied to the laminated plate. Impact unit 24 is operated to propel the blade upwardly to form a trigger cut in the lower edge of the laminated plane along a cleavage plane and the combination of the trigger cut and the splitting strain causes the plate to split into two parts. These two parts should be of equal or substantially equal thickness as a result of the self-centering device.

A transfer mechanism is mounted above the splitting unit 11. The transfer mechanism is for taking hold of the two parts of laminated plate split in the first splitting unit and for transferring the two plate parts to the splitting units 12 and 13. The construction of each of the splitting units 12 and 13 is almost identical to that of splitting unit 11 and corresponding component parts are given identical reference numbers but with suffixes 'a' and 'b'. The only significant difference between each of the splitting units 12 and 13 and the splitting unit 11 is that the gripper members 14a and 14b of the splitting units 12 and 13 respectively are fixed to a central support 38. Hence, only the gripper members 15a and 15b have associated piston and cylinder units 19a and 19b respectively.

The transfer mechanism 37 comprises a carrier in the form of a wheeled carriage 39 mounted on rails 40 which are fixed to the support structure 10 above the splitting units 11—13. Two holding devices 41 and 42 depend from the carriage 39. Each holding device comprises a pair of arms 43, 44 pivotably connected to the carriage about a common axis 45 (see Fig. 2). A pneumatic piston and cylinder unit 46 is associated with each holding device to pivot the arms 43 and 44 relative to each other. The cylinder is mounted on the upper end of the arm 43 and the piston rod is connected to the upper end of the arm 44. Friction pads 47 are secured to the lower ends of the arms 43 and 44 to grip one of the parts of the laminated plate split in the splitting unit 11. By extending the piston rod, it will be apparent that the arms 43 and 44 will pivot in such a way as to bring the pads 47 into engagement with opposed faces of the laminated plate part and by retracting the piston rod, the arms 43 and 44 will pivot in such a way as to release the laminated plate part. The piston rod of the holding device 41 is shown withdrawn in both Figure 1 and Figure 2 and the piston rod of the holding device 42 is shown withdrawn in Figure 1, but extended in Figure 2.

The arms of each holding device are jointly and

freely pivotable about their respective axis 45.

The carriage is movable along the rails 40 by a further piston and cylinder unit mounted at the end of the housing at which the splitting unit 11 is located.

A supply of negative pressure to the suction devices of the first splitting unit 11 is maintained until the suction devices have both moved fully apart so that the respective plate parts split by the splitting unit 11 are withdrawn with the suction devices. This is necessary in order to locate the plate parts in a position in which the holding devices 41 and 42 can take hold of these plate parts. Immediately after the holding devices 41 and 42 have taken hold of the plate parts in the first splitting unit, each holding device with its associated plate part pivots away from the respective suction device of the first splitting unit owing to the weight of the cylinder of the respective piston and cylinder unit 46. This moves the plate parts clear of the respective suction devices of the first splitting unit so that they may be transferred to respective second and third splitting units where each part is once again split in half. Guides 48 and 49 (see Fig. 3) fixed to the central support 38 are engageable by the holding devices 41 and 42 or by the plate parts held thereby as they approach respective second and third splitting units in order to re-orientate the plate parts vertically before they are loaded in the second and third splitting units.

The gripper members 14a and 15a, 14b and 15b are mounted on a common axis and are caused to grip respective plate parts before the respective holding devices 41 and 42 release the plate parts. This will ensure that the plate parts do not strike the base plates of the gripping units 12 and 13 with the consequential risk of damaging the plate parts.

The upper end of the support structure 10 is enclosed in a transparent cover having a vertically slidable access door at each end. This transparent cover extends down at least to the level of the base plates below the gripper members. The lower end of the apparatus is enclosed by removable panels which allow access for maintenance purposes.

The transparent cover has a peripheral air in bleed opening at its lower end and an opening in its top surface which is connected by a flexible hose to an extractor fan which promotes a flow of air through the cover. Thus, dust and other minor particles which are released at an instance of splitting and which may be injurious to an operator are extracted.

The timing of the various pneumatic piston and cylinder units is controlled by a microprocessor. The apparatus is only operable when both doors are closed and the doors are provided with pneumatic locking devices to prevent one or other door from being opened during a splitting operation.

#### CLAIMS

1. Apparatus for cleaving laminated material,

provided with first, second and third splitting units contained in a common housing, each splitting unit comprising two gripper members, first power operated means for relatively moving the gripper members towards and away from each other such that, in use, with a plate of laminated material disposed between the gripper members, the latter can be moved relatively towards each other to grip opposite faces of the plate and then can be moved relatively away from each other to apply a splitting strain to the plate, a blade, and second power operated means for causing the blade to apply an impact to the plate in a direction perpendicular to the direction of relative movement of the gripper members to form a trigger cut at an edge of a desired cleavage plane, and a transfer mechanism for taking hold of the two parts of a laminated plate split in the first splitting unit and transferring said two parts to the second and third splitting units respectively.

2. The apparatus of claim 1, wherein the transfer mechanism comprises a carrier, two holding devices mounted on the carrier for releasably taking hold of the two plate parts, and third power operated means for moving the carrier from a position in which the holding devices can take hold of the two plate parts to a position in which the two holding devices can load the two plate parts into the second and third splitting units respectively.

3. The apparatus of claim 2, wherein the splitting units are arranged to receive vertically oriented laminated plates or plate parts and wherein the carrier is a wheeled carriage mounted on rails disposed above the splitting units and the two holding devices depend from the carriage.

4. The apparatus of claim 2 or claim 3, wherein each holding device comprises a pair of pivotably mounted arms and fourth power operated means for pivoting the arms relative to each other so as to in use bring the arms into engagement with opposite faces of a plate part and to subsequently release the plate part.

5. The apparatus of any one of the preceding claims, wherein each gripper member comprises a suction device connected to a source of negative pressure.

6. The apparatus of claim 5, wherein the suction devices of the first splitting unit are both movable and have associated control means for maintaining a supply of negative pressure thereto after a splitting operation until the suction devices have both moved fully or substantially fully apart so that, in use, the respective plate parts are withdrawn with the suction devices.

7. The apparatus of claim 6, when dependent on claim 4, wherein the arms of each holding device are jointly and freely pivotable about a common axis and each holding device is weighted such that, after it takes hold of a plate part, the holding device with the plate part pivots in one angular direction away from the suction device of the first splitting unit.

8. The apparatus of claim 5, 6 or 7, wherein the second and third splitting units each have one





fixed and one movable suction device, the movable suction devices of the second and third splitting units being movable along a common axis.

5 9. The apparatus of claim 8 when dependent on claim 7, wherein guides are provided for pivoting each of the holding devices in an angular direction opposite to said one angular direction as they approach respective second and third splitting  
10 units.

10. The apparatus of claim 2 or any other claim when dependent on claim 2, wherein control means are provided for causing the gripper members of the second and third splitting units to  
15 grip respective plate parts prior to the respective holding devices releasing the plate parts.

11. The apparatus of any one of the preceding claims, wherein the first splitting unit is mounted at one end of the housing and the second and  
20 third splitting units are mounted at an opposite end of the housing, the housing having a first openable closure at the said one end for loading a laminated plate to be split into said first splitting unit and a second openable closure at the  
25 opposite end of the housing for unloading split plate parts from the second and third splitting units.

12. The apparatus of claim 11, wherein the first and second openable closures are provided with  
30 locking devices to prevent one or other closure from being opened during a splitting operation.

13. The apparatus of any one of the preceding claims, wherein at least one air inlet opening is provided in the housing and the interior of the  
35 housing communicates with air extraction means for promoting a flow of air through the housing sufficient to extract dust particles from the interior of the housing.

14. The apparatus of any one of the preceding  
40 claims, wherein the blade of each splitting unit is mounted in a carriage guided for movement in a direction parallel to the direction of relative movement of the gripper members and wherein each splitting unit has a self centering device for  
45 positioning its associated blade midway or substantially midway between its associated gripper members prior to an impact stroke of the blade.

15. The apparatus of claim 14, wherein for  
50 each splitting unit one of the gripper members is movable and the other is fixed or arranged, in use,

to reach a predetermined position prior to the one gripper closing in on the laminated plate and the self centering device comprises a lever arm  
55 connected intermediate its ends to the carriage for pivotable movement about a first axis normal to the direction of relative movement of the gripper members and normal to the direction of movement of the blade during an impact stroke,  
60 contactable at one end by an abutment fixed to the one gripper member and mounted at its other end for pivotable movement about an axis substantially fixed in space and resilient means urging the carriage with the lever arm towards the  
65 abutment on said one gripper member, the distance between the position of contact of the lever arm with the abutment and the second axis being twice or substantially twice the distance between said contact position and the first axis and the arrangement being such that when the  
70 abutment contacts the lever arm the blade in the carriage is midway between the gripper members so that further movement of the one gripper member towards the other gripper member will  
75 result in the blade moving half the distance travelled by the one gripper member.

16. The apparatus of claim 5 or any other claim when dependent on claim 5, wherein each suction device comprises a rigid plate having an annular  
80 seal or compressible resilient material on that face thereof adjacent to the other suction device.

17. The apparatus of claim 16, wherein the annular seal is formed of cellular material.

18. A method of cleaving laminated material  
85 using the apparatus of any one of the preceding claims and comprising the steps of: (a) disposing a plate of laminated material between the two gripper members of the first splitting unit, then (b) relatively moving the gripper members towards  
90 each other to grip the plate of laminated material, then (c) relatively moving the gripper members away from each other to apply a splitting strain to the plate of laminated material, then (d) forming a trigger cut at an edge of a desired cleavage plane  
95 of the plate of laminated material, then (e) transferring the plate parts to the second and third splitting units respectively, and then (f) repeating steps a—d in each of the second and third splitting units.

100 19. Laminated material split by the method of claim 18.

20. Slate split by the method of claim 18.

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